



Federal Space Agency



GLONASS: Current status and perspectives

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□ **State Policy principles**

- **GLONASS current status**

- **GLONASS modernization plans**

- **GLONASS augmentations**



State policy principles



- ❑ **No direct user fees exist for the GLONASS service**
- ❑ **Open access is guaranteed to the GLONASS signal structure for user equipment and applications development**
- ❑ **Application of combined GLONASS/GPS receivers is promoted within Russian territory**
- ❑ **Compatibility and interoperability of GLONASS with GPS and future GALILEO has to be maintained**
- ❑ **GLONASS involvement in the GNSS global markets is a target**



- **President Resolution, 1999**
- **Government Resolution, 1999**
- **Federal Program «Global Navigation System» (GLONASS program), 2001**
- **Concept of Russian Federation united position navigation and time system, 2004**

GLONASS is a basement of united position navigation and time service



Basic topics of federal GLONASS program



□ **GLONASS system maintenance and development**

- Minimum constellation size (18 satellites) – 2007
- Full constellation (24 satellites) – 2009

□ **Development and production of the GNSS user equipment for all applications**

- Combined GNSS receivers
- Integrated systems based on GNSS technology
- Receiver components creation

□ **Navigation technology integration into transport infrastructure**

□ **Geodetic reference frames modernization**

**Federal GLONASS Programme is
directly funded from the Federal Budget
with annual corrections**

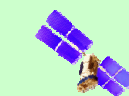


- **State Policy principles**
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15 satellites on orbit

- **11 SV «GLONASS» (3 yrs life-time):**
- **4 SV «GLONASS-M» (7 yrs life-time)**
 - 2 operational
 - 2 undergo flight test

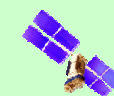
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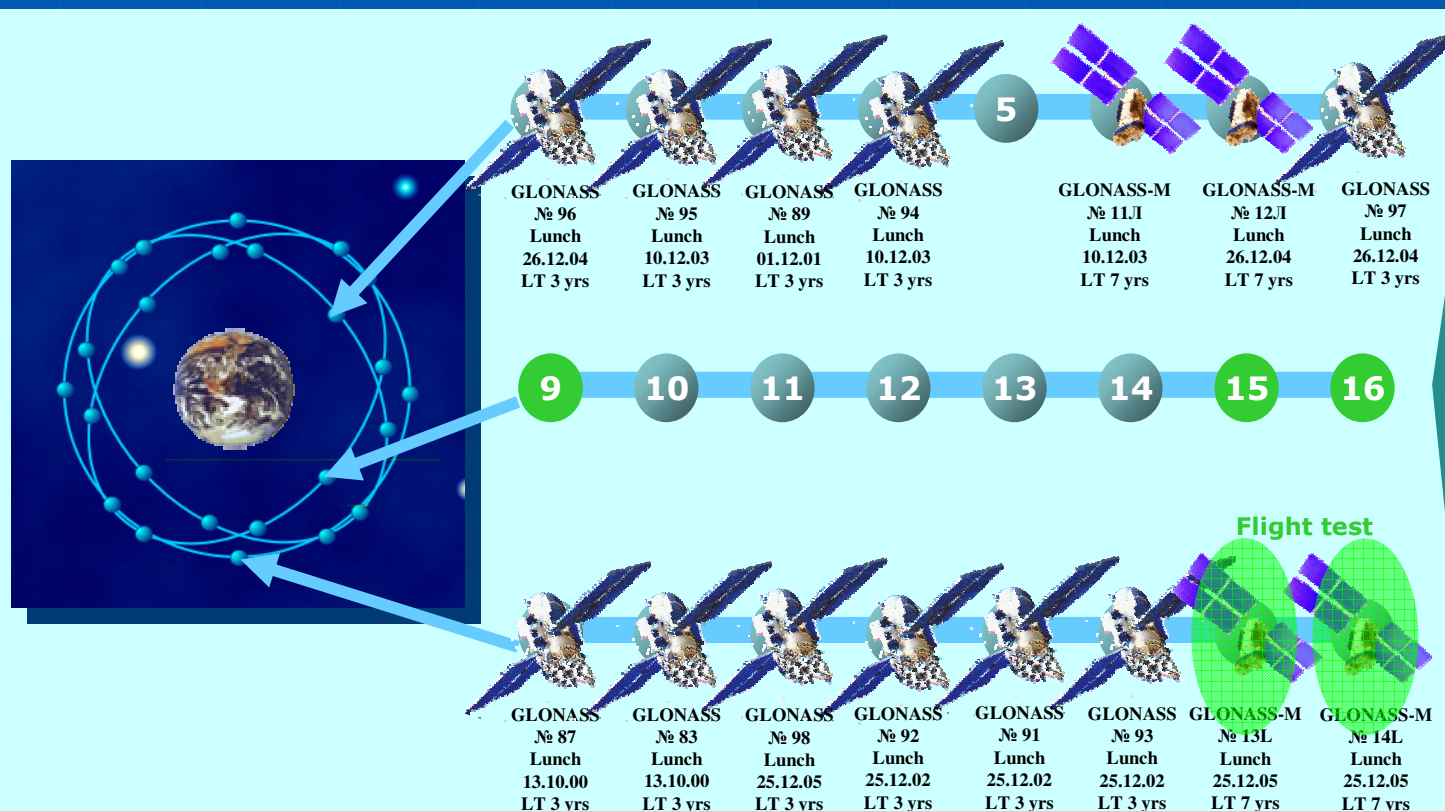
GLONASS-M
№15
LT 7yrs



GLONASS-M
№16
LT 7 yrs

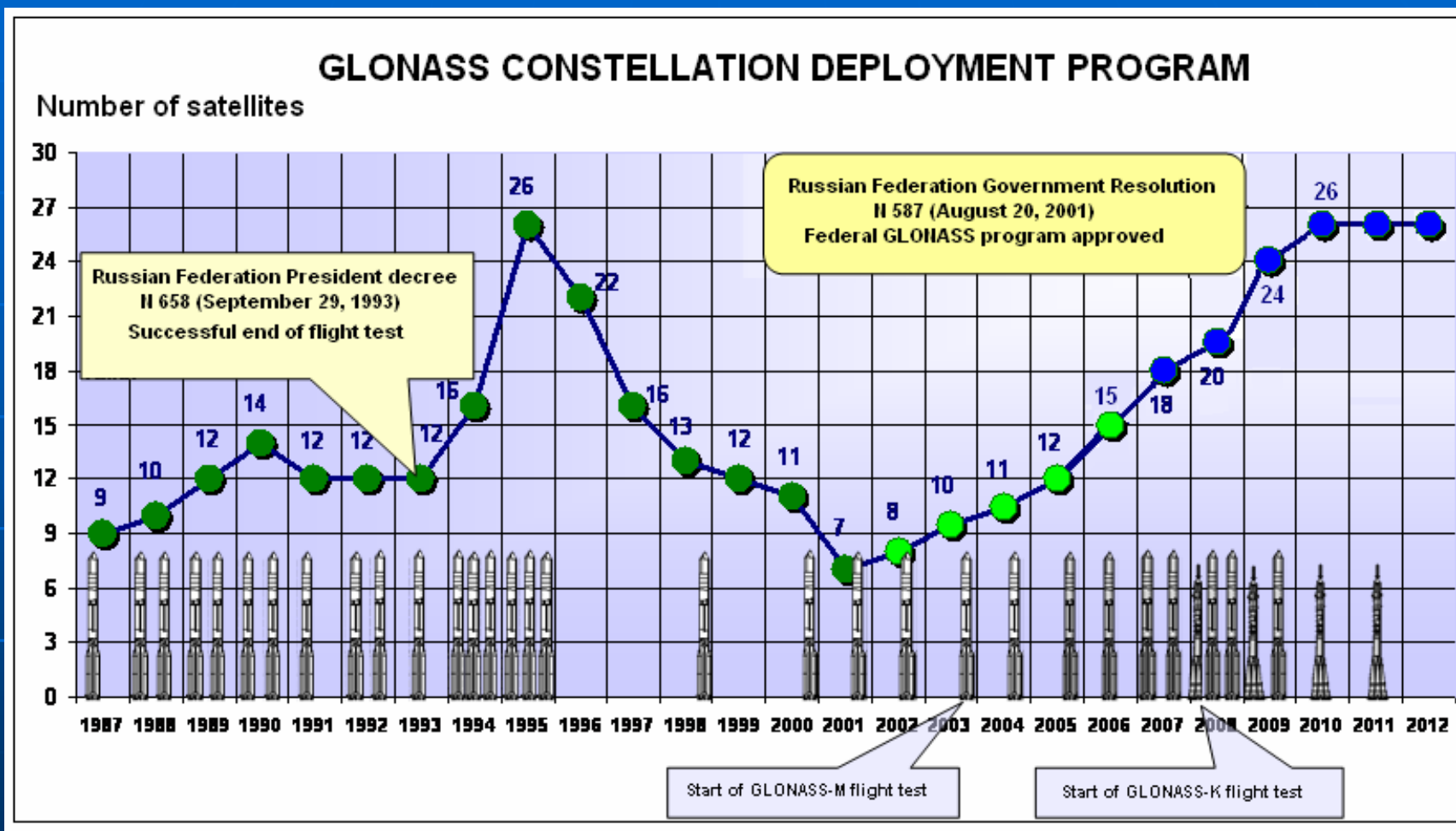


GLONASS-M
№17
LT 7yrs





Constellation history and perspectives



GLONASS deployment milestones:

- 18 satellites in constellation – 2007
- 24 satellites in constellation – 2009



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GLONASS modernization plans



- ❑ **Modernization of on-board major components, including payload**
- ❑ **Navigation signals modernization**
- ❑ **Upgrade GLONASS ground segment**

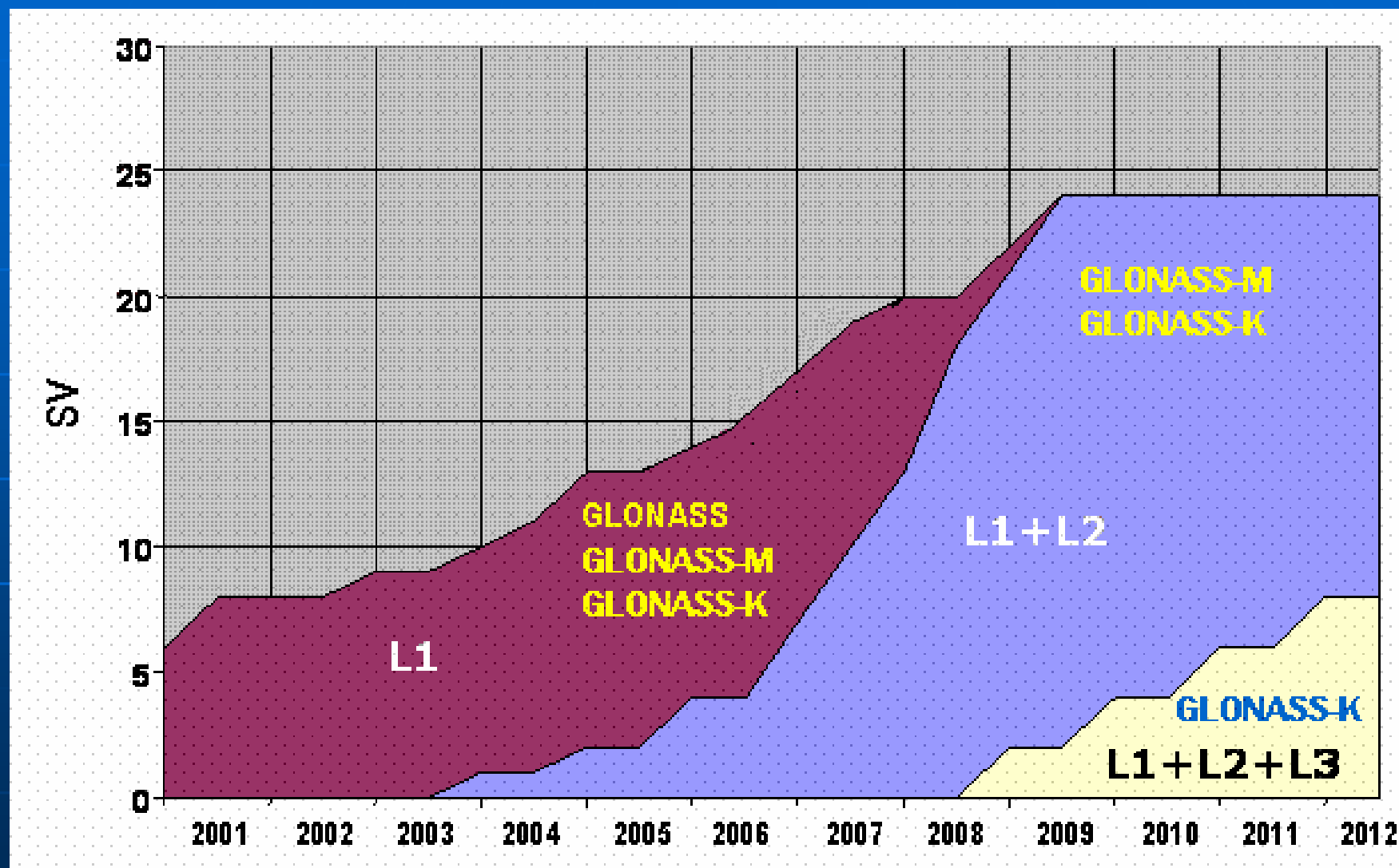




- ❑ **New signals additional transmitters development**
- ❑ **Intersatellite link creation**
- ❑ **Navigation message self-descriptiveness increasing**

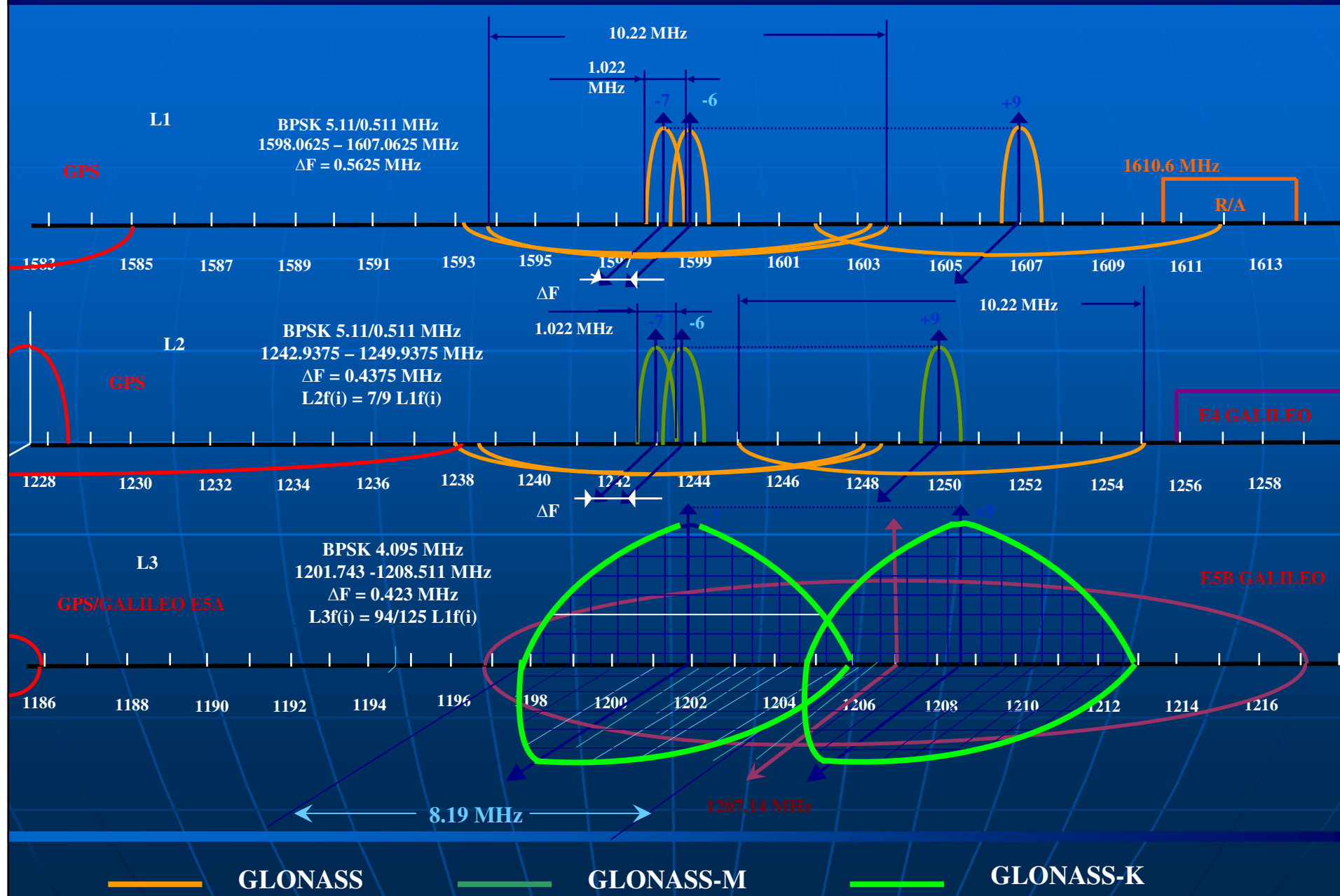


Navigation signals



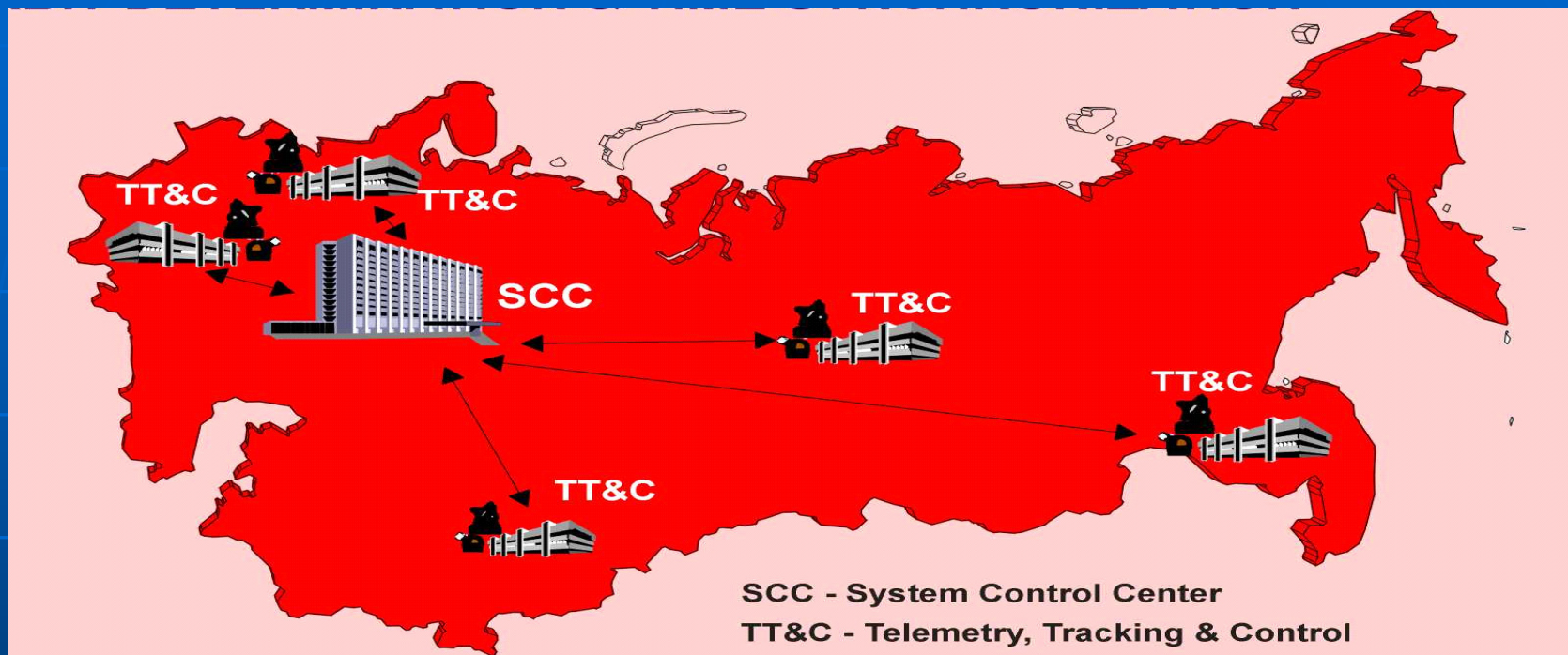


GLONASS signals modernization





GLONASS control segment modernization



Modernization program

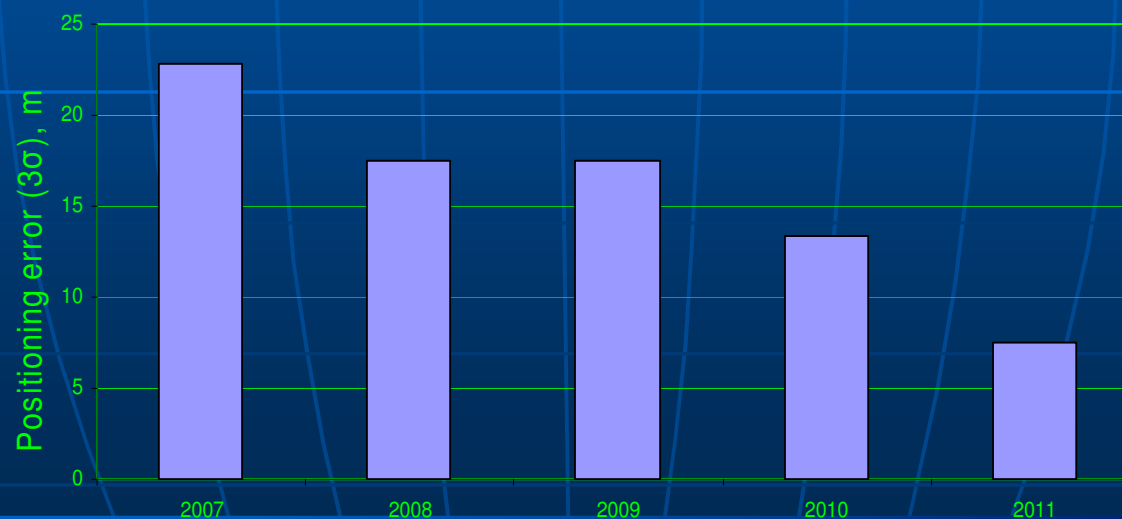
- ❑ One-way measurement and ephemeris computation stations network development
- ❑ One-way measurement stations network creation
- ❑ Two-way measurement stations deployment
- ❑ Communication channels modernization



Navigation accuracy



	2007	2008	2009	2010	2011
Ephemeris and clock accuracy (σ)					
along track, m	5	3,5	1,5	1,2	1
cross track, m	5	3,5	1	0,8	0,5
radius, m	1	0,5	0.3	0,25	0,25
synchronization, ns	6	4	3	2	2
Positioning accuracy (σ)					
horizontal, m	3	3	3	2	1.5
vertical, m	7	5	5	4	2





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GLONASS augmentations



- **Russian wide-area differential subsystem**
- **GLONASS/GPS integrity monitoring subsystem**
- **Regional differential subsystems**



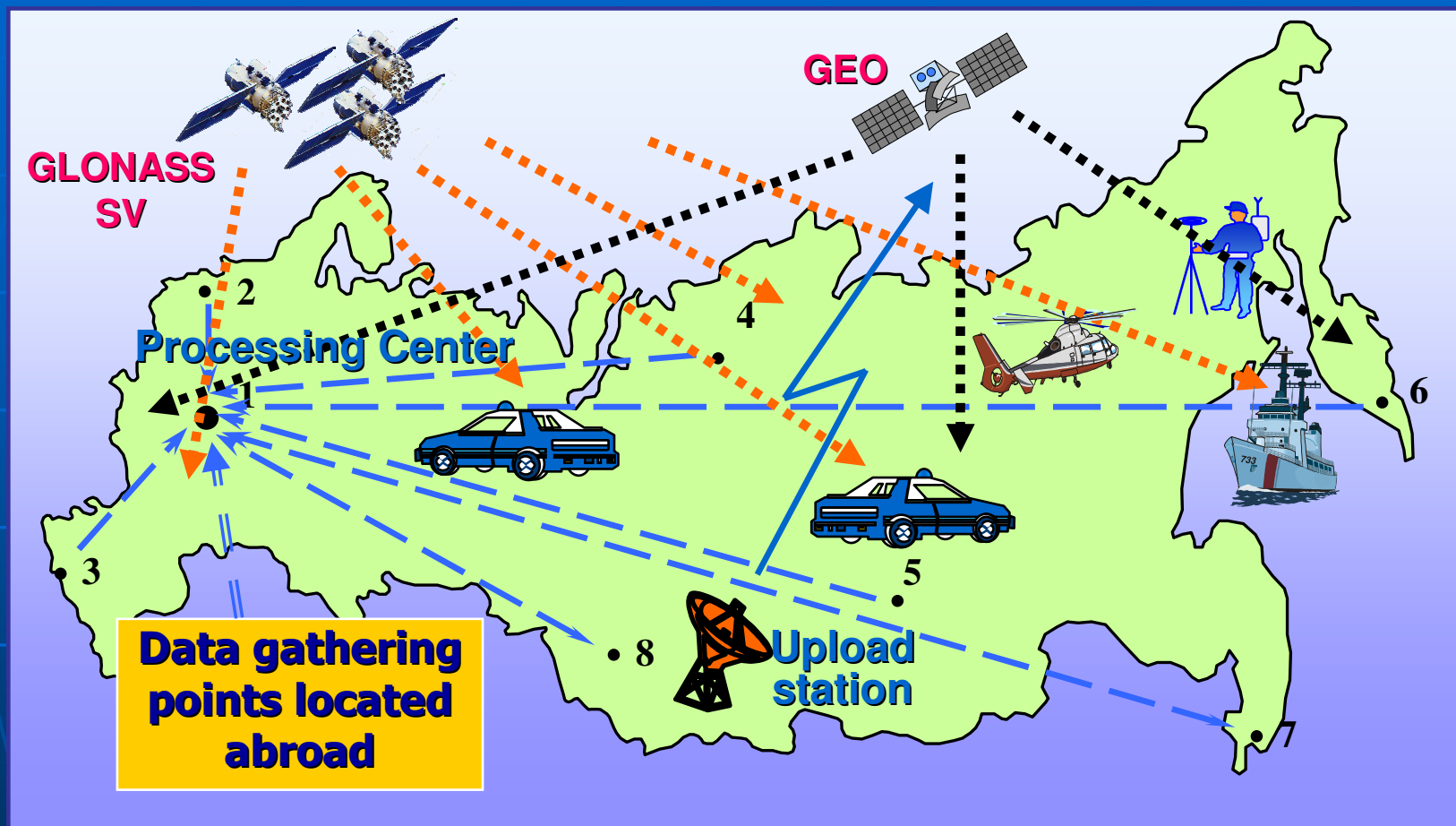
SDCM goals

Based on GLONASS/GPS signals:

- 1) Provide «meter level» of position determination accuracy in real time**
 - horizontal: 1.0 - 1.5 m
 - vertical: 2.0 - 3.0 m
- 2) Provide «centimeter level» of position determination in real time (with ground stations support)**
 - horizontal: 1 - 2 cm
 - no vertical: 4 – 6 cm
- 3) Making operative integrity monitoring**
- 4) Making a posteriori integrity monitoring**



SDCM architecture



Data gathering points in Russia (as of 2006):

1 – Moscow; 2 – Pulkovo (S. Petersburg); 3 – Kislovodsk; 4 – Norilsk; 5 – Irkutsk; 6 – Petropavlovsk; 7 – Khabarovsk; 8 – Novosibirsk



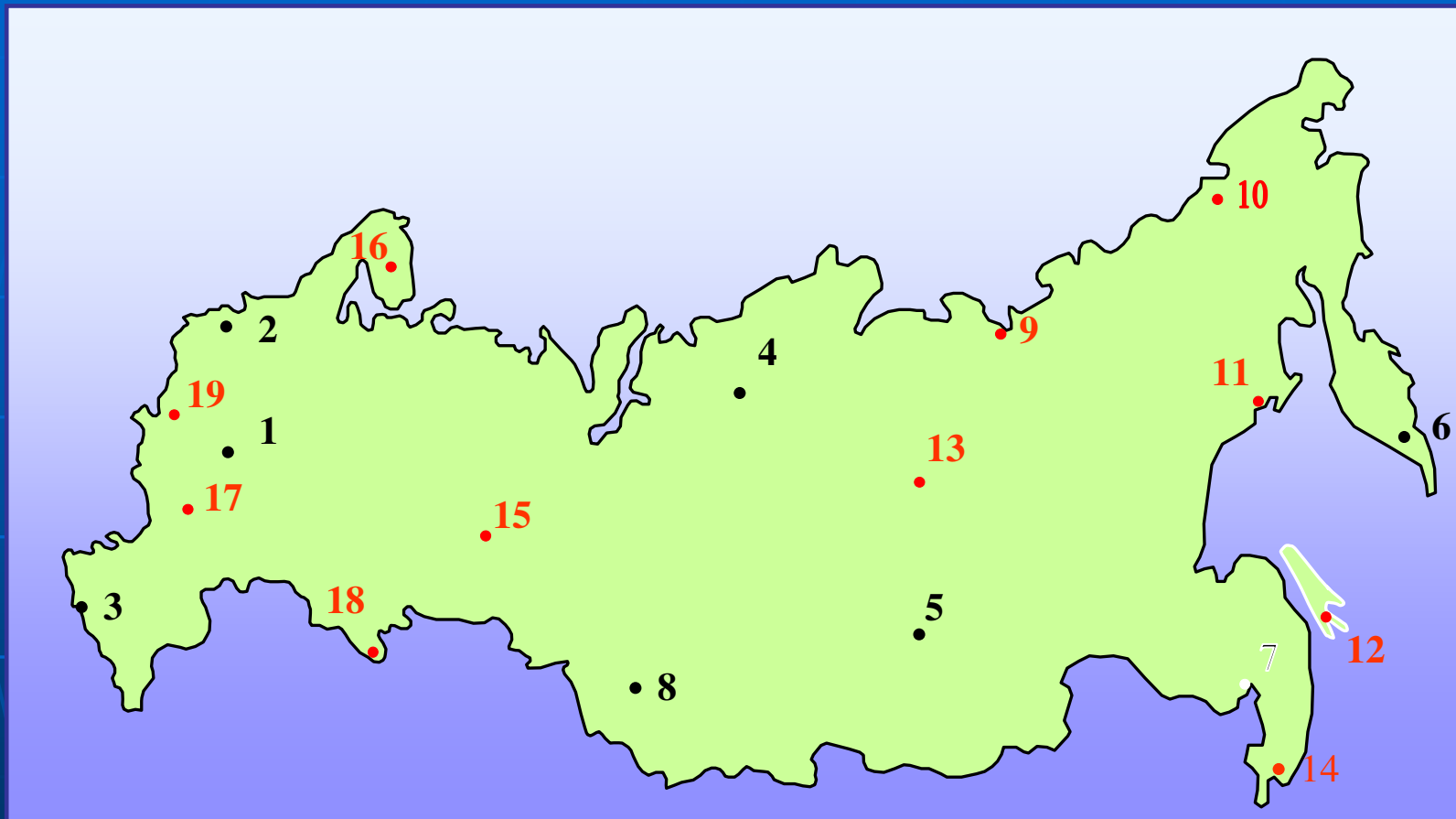
SDCM development plans



- **Data gathering network development**
2007 - 2008
- **Satellite transponder design and manufacturing**
2008
- **Ground uplink station creation**
2008
- **System flight test**
2009-2010



Data collection network development program



Existing station (end 2005):

1 – Moscow; 2 – Pulkovo (S.Petersburg); 3 – Kislovodsk; 4 – Norilsk; 5 – Irkutsk;
6 – Petropavlovsk; 7 – Khabarovsk; 8 – Novosibirsk

Data gathering point (future):

9 – Tiksi; 10 – Bilibino; 11 – Magadan; 12 – Yugno-Sahalinsk; 13 – Yakutsk; 14 – Vladivostok; 15-
Ekaterinburg; 16- Lovozero; 17 – Voroneg; 18 – Anapa; 19 – Pecheri.



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Thank you for attention!



GLONASS modernization plans



- ❑ **Retrofitting ground segment**
- ❑ **Modernization of the GLONASS time keeping system**
- ❑ **Improving ground measurement processing techniques to achieve better ephemeris and clock accuracy based on combination of one-way and two-way measurement**
- ❑ **Improving stability of onboard satellite clock**
- ❑ **Improving Geodetic Reference Frame PZ-90 to agree it with ITRF**
- ❑ **Introduction of the third civil signal in L3 starting with GLONASS-K in 2008**
- ❑ **Providing GLONASS with Search and Rescue capability (starting with GLONASS-K) in a way similar to COSPAS-SARSAT**





Basic Improvements in GLONASS-M Compared with GLONASS Spacecraft



(Details: GLONASS Interface Control Document (ICD), version 5, 2002)

- ❑ **L2 signal is modulated with civil code**
- ❑ **Better onboard frequency standard (1×10^{-13} vs. 3×10^{-13})**
- ❑ **Extra parameters are added into navigation message:**
 - Accuracy factor (URA analog), temporarily set to “not monitored”
 - B1, B2 – coefficients for calculating UT1
 - KP – sing of coming “leap” second
 - N4 – sequential number of 4-year interval starting with 1996
 - N_T – day sequential number within 4-year interval
 - $\Delta\tau_n$ – onboard L1/L2 signal delay difference
 - $\Delta\tau_{GPS}$ – GPS/GLONASS time offset